

173-175 FRIAR STREET AND 27-32 MARKET PLACE

READING, UK

PEDESTRIAN LEVEL WIND DESK BASED ASSESSMENT

RWDI #1801400A

FEBRUARY 6, 2018

SUBMITTED TO

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TABLE OF CONTENTS

1.	EXECUTIVE SUMMARY	1
2.	INTRODUCTION	2
3.	SITE DESCRIPTION	2
3.1	Site and Surroundings	2
3.2	The Proposed Development.....	3
4.	METHODOLOGY AND ASSESSMENT CRITERIA	4
4.1	General Meteorological Data	4
4.2	Terrain Roughness	5
4.3	Comfort Criteria	5
4.4	Strong Winds.....	6
5.	PREDICTED WIND CONDITIONS	7
5.1	Existing Site and Surroundings	7
5.1.1	Pedestrian Comfort	7
5.1.2	Strong Winds	7
5.2	Future Wind Conditions	7
5.2.1	Pedestrian Comfort	8
5.2.2	Strong Winds	10
6.	CONCLUDING REMARKS	10
7.	REFERENCES	10



1. EXECUTIVE SUMMARY

The following report includes a qualitative assessment of the wind microclimate on and around the proposed 173-175 Friar Street and 27-32 Market Place Development in Reading, UK. The assessment is based on an analysis of the meteorological data for Heathrow Airport adjusted to the Site through a terrain roughness analysis, a review of the design drawings received from Rodić Davidson Architects on January 22 and February 6, 2018, review of wind-tunnel studies undertaken by RWDI for similar projects in the Reading area and our engineering judgment and knowledge of wind flows around buildings.

The Proposed Development is an 8-storey mixed-use building, with stepped façade on the north, south and west sides creating terraces and green roofs at various levels.

Overall, the wind microclimate around the Proposed Development is expected to be suitable for the intended use on and around the site including public thoroughfares and most entrances. However, conditions are expected to be occasionally windier than desired at the residential entrance on the south side of the public thoroughfare, during the windiest season. Wind mitigation features have been recommended which can help to improve the conditions at this location.

2. INTRODUCTION

RWDI was retained by Savills to conduct a desk based assessment of the pedestrian wind conditions for the proposed 173-175 Friar Street and 27-32 Market Place Development in Reading, UK.

The assessment is based on an analysis of the meteorological data for Heathrow Airport adjusted to the Site through a terrain roughness analysis, a review of the design drawings received from Rodić Davidson Architects on January 22 and February 6, 2018, a review of wind-tunnel studies undertaken by RWDI for similar projects in the Reading area and our engineering judgment and knowledge of wind flows around buildings.

This report presents the background, objectives, results and recommendations from RWDI's assessment. A summary of the overall recommendations from the study are presented in Section 7, "Concluding Remarks".

3. SITE DESCRIPTION

3.1 Site and Surroundings

The existing Site is located at the centre of Reading, south of Friar Street and west of Market Place (Figure 1). The Site is immediately surrounded by low to mid-rise buildings in all directions. A number of mid-rise buildings are located to the east and south sides of the site and parks and open fields are to the north and northeast.

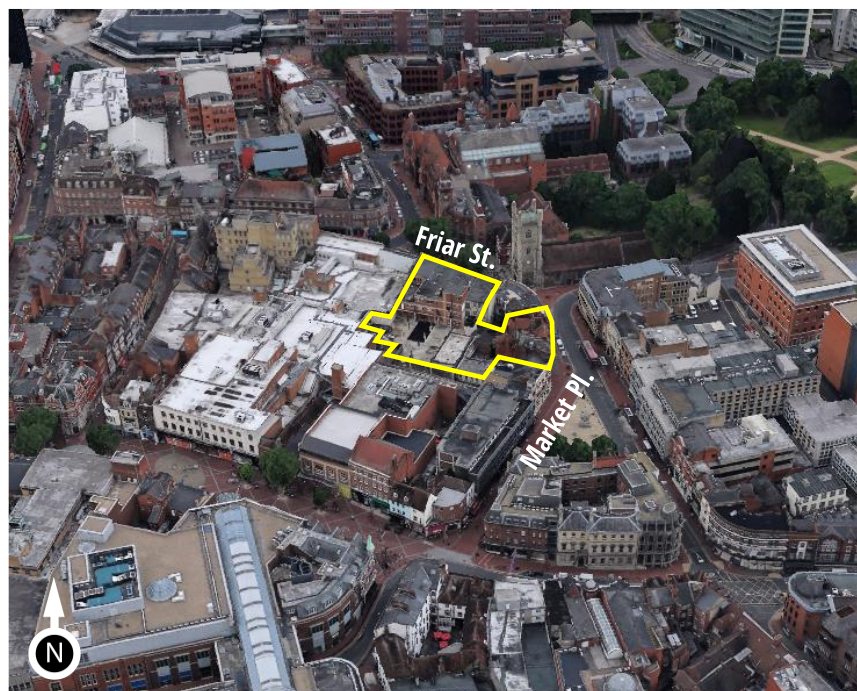


Figure 1: Aerial view of the Existing Site and Surrounding (Courtesy of Google™ earth)

The low and mid-rise surroundings or open terrain means the approaching winds have less obstacles to negotiate, in comparison to more urban high-rise areas such as central London. This allows the wind to flow more freely at ground level, resulting in higher mean wind speeds. However, the low-rise surroundings also create fewer gusts which are driven by turbulence generated by the terrain roughness.

3.2 The Proposed Development

The Proposed Development consists of an 8-storey mixed-use building at 173-175 Friar St. to the east and two 4-storey buildings at 27-32 Market Place to the west (see Figure 2). The 173-175 Friar St. portion has stepped façade on the north, south and west sides, creating terraces and green roofs at various levels (see Figure 2). A public thoroughfare is located between the two portions of the development (see Figure 2).

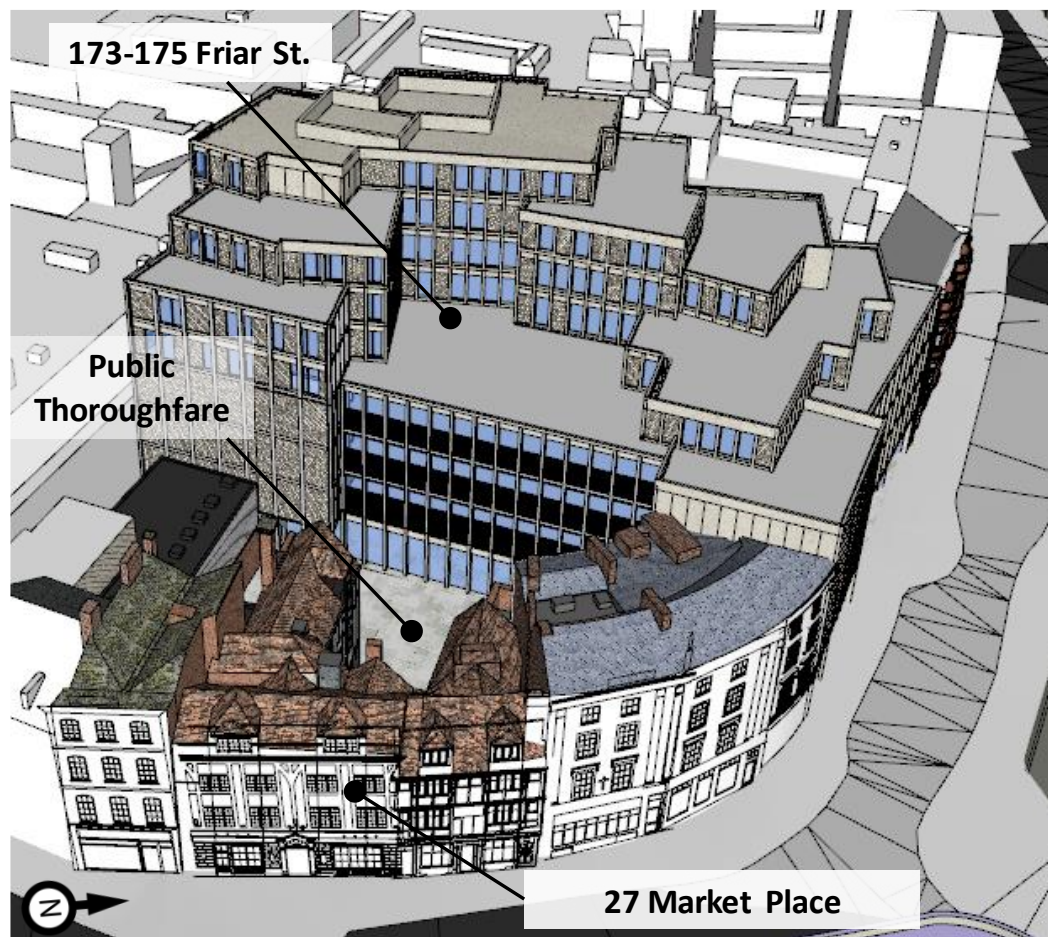


Figure 2: 3D rendering of the proposed development (view from east)

4. METHODOLOGY AND ASSESSMENT CRITERIA

Knowledge of the prevailing wind directions focuses attention on the likely impact of these winds on the Site except where the proposed building massing / layout indicates that winds from other directions are likely to be important.

4.1 General Meteorological Data

Meteorological data from Heathrow Airport has been corrected to standard conditions of 10m above open flat level country terrain (Figure 3). The meteorological data is combined with terrain roughness values obtained from the BREVe 3.2 software package to allow for data to be adjusted to Site specific conditions.

Approximately 30 years of meteorological data from Heathrow Airport are used for this analysis as presented in Figure 3 as wind roses for each season. Wind speed is represented by Beaufort Force ranges while the radial axes represent the cumulative number of hours per season that the wind speed exceeds the particular Beaufort Force from any given circumferential direction. The assessment presented in this report focusses on the windiest season, generally winter (December to February) in northern Europe, representing a 'worst-case' scenario, and a summer season (June to August), when amenity spaces are expected to be most frequently used.

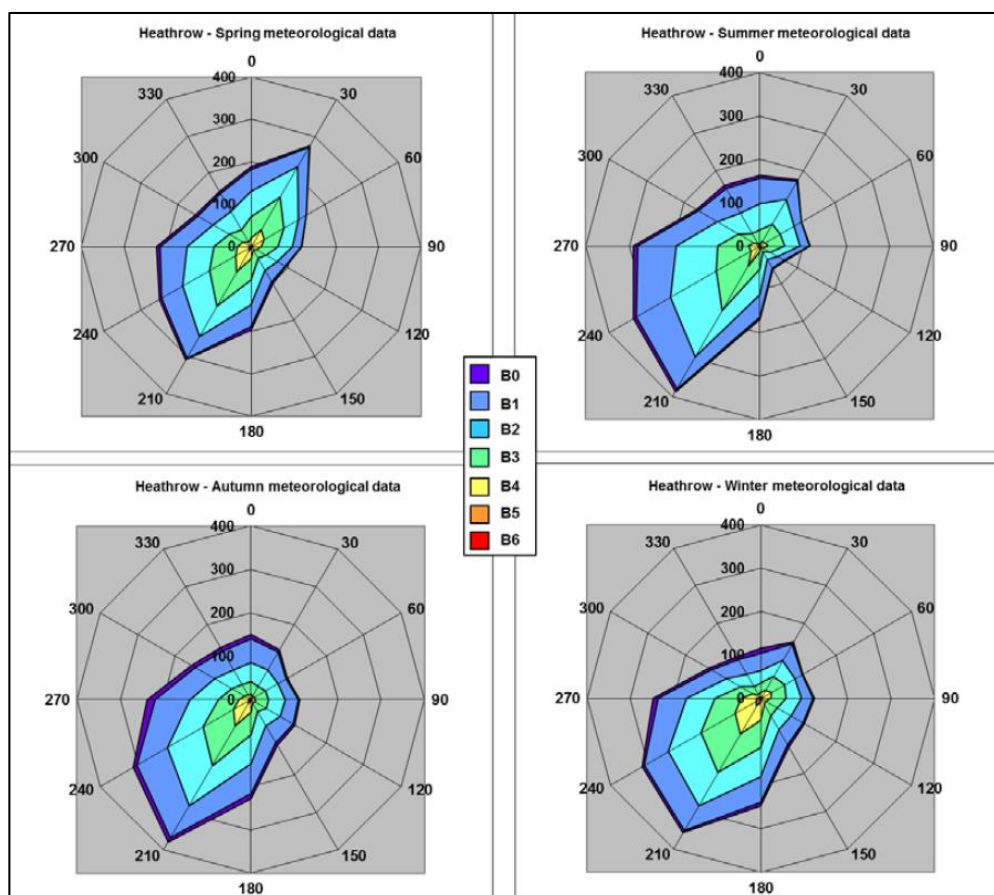


Figure 3: Directional distribution of winds approaching Heathrow Airport

The meteorological data presented in Figure 3 indicate that the prevailing winds throughout the year are for the southwest. This is typical for many areas of southern England. The windiest season in northern Europe typically being the winter. Secondary winds are from northeast, especially during the spring, which tends to be cold winds. During the summer season winds are generally one comfort category calmer than during the other seasons.

4.2 Terrain Roughness

To account for the difference in height and terrain roughness between the meteorological station and the Site, it is necessary to apply adjustment factors (mean factors) to the meteorological data. An assessment of the terrain roughness for the Site was conducted using the BREVe3 software.

Table 1 presents the ‘mean factors’ for the Site where the mean factor represents the ratio of wind speed on Site, at the stated reference height, as a fraction of the wind speed in open, flat countryside at a height of 2m and 10m above grade level.

Table 1: BREVe3 mean factors at 2m and 10m above grade level

Wind Direction>>	0°	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°	330°
Mean Factor at 2m	0.43	0.44	0.45	0.43	0.42	0.44	0.44	0.46	0.44	0.43	0.44	0.43
Mean Factor at 10m	0.80	0.82	0.84	0.80	0.78	0.81	0.82	0.85	0.82	0.79	0.82	0.80

4.3 Comfort Criteria

The assessment of the wind conditions requires a standard against which the measurements can be compared. This report uses the Lawson Comfort Criteria, which have been established for over thirty years. The Criteria, which seek to define the reaction of an average pedestrian to the wind, are described in Table 2. If the measured wind conditions exceed the threshold wind speed for more than 5% of the time, then they are unacceptable for the stated pedestrian activity and the expectation is that there may be complaints of nuisance or people will not use the area for its intended purpose.

The Criteria set out five pedestrian activities with an associated range of wind speeds which reflect the fact that less active pursuits require more benign wind conditions. In ascending order of activity level, the categories are:

- Sitting;
- Standing or entering/leaving a building
- Strolling;
- Walking; and
- Uncomfortable.

Wind conditions in an area intended for sitting need to be calmer than a location that people merely walk past and this is reflected in the Comfort Criteria. The Criteria are derived for open air conditions and assume that pedestrians will be suitably dressed for the season.

The distinction between strolling and walking is that in the former scenario pedestrians are more likely to take on a more leisurely pace, with the intention of taking time to move through the area, whereas in the walking scenario pedestrians are intending to move through the area quickly and are therefore expected to be more tolerant of windier conditions.

Table 2: Lawson Comfort Criteria

Comfort Category	Threshold	Description
Sitting	0-4 m/s	Light breezes desired for outdoor restaurants and seating areas where one can read a paper or comfortably sit for long periods
Standing	4-6 m/s	Gentle breezes acceptable for main building entrances, pick-up/drop-off points and bus stops
Strolling	6-8 m/s	Moderate breezes that would be appropriate for window shopping and strolling along a city/town centre street, plaza or park
Walking	8-10 m/s	Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering
Uncomfortable	>10 m/s	Winds of this magnitude are considered a nuisance for most activities, and wind mitigation is typically recommended

Generally, the target conditions are:

- Strolling conditions during the windiest season on pedestrian thoroughfares (with walking conditions potentially being tolerated in areas where pedestrians would not linger);
- Sitting or Standing conditions at entrances, drop off areas or taxi ranks, and bus stops throughout the year; and,
- Sitting conditions at outdoor seating and amenity areas during the summer season when these areas are more likely to be frequently used by pedestrians. It is noted that in large mixed use amenity spaces a mixture of sitting and standing conditions can be considered acceptable as users can choose to sit in 'calmer' areas, with 'windier' areas acceptable for more active pursuits.

The wind conditions in an area for sitting need to be calmer than a location that people merely walk past and this is reflected in the Comfort Criteria. The Criteria are derived for open air conditions and assume that pedestrians will be suitably dressed for the season. The criteria address the force of the wind on a person, or activity, they do not take account of thermal factors.

4.4 Strong Winds

Lawson¹ also specified strong wind threshold when winds exceed 15m/s for more than 0.025% of the year. Exceedance of this threshold may indicate a need for remedial measures or a careful assessment of the expected use of that location.

Strong winds are generally associated with areas which would be classified as acceptable for walking or as uncomfortable. In a mixed-use urban development scheme, walking and uncomfortable conditions would not usually form part of the 'target' wind environment and would usually require mitigation due to pedestrian comfort considerations. This mitigation would also reduce the frequency of, or even eliminate, any strong winds.

5. PREDICTED WIND CONDITIONS

5.1 Exiting Site and Surroundings

Often a new development will alter the pedestrian activity (i.e. intended use) on Site and, therefore, a comparison between the original wind conditions with those on the development Site is presented. Occasionally, although wind conditions may not change after the proposed development is completed (e.g. stay at strolling level), mitigation would still be required if on the new development the location of interest is intended for a critical activity (e.g. a main entrance) for which the wind condition would be unsuitable. Assessment in terms of the desired pedestrian activity on or around a Site takes into consideration any change of use and this is where the comfort criteria are particularly helpful.

5.1.1 Pedestrian Comfort

The existing Site is currently occupied by low-rise buildings, ranging from 1 to 4-storeys. The surrounding buildings in the direction of the prevailing winds (southwest direction) are generally of a similar height as the exiting building on Site and are not expected to cause extreme local wind acceleration. Wind conditions on and around the site, including Friar Street and Market Place would be suitable for standing use in the windiest season and sitting in the summer.

5.1.2 Strong Winds

For the exiting Site, no strong winds in excess of 15m/s are expected to occur for more than 0.025% of the time.

5.2 Future Wind Conditions

The proposed building is exposed to the prevailing winds. Buildings taller than their surroundings tend to intercept the stronger winds at higher elevations and redirect them to the ground level. Such a Downwashing flow (see Figure 4a) is the main cause for increased wind activity around taller buildings at the grade level. When oblique winds are deflected down by a building, a localised increase in the wind activity can be expected around the downwind building corner at pedestrian level (see Figure 4b). If these building/wind combinations occur for prevailing winds, there is a greater potential for increased wind activity. The impact of such a Downwashing Flow at grade level is reduced by wide podium setbacks and stepped buildings forms (Figure 4c). However, increased wind activity will be created on the lower windward roofs or terraces where low wind speeds are typically desired for amenity use.

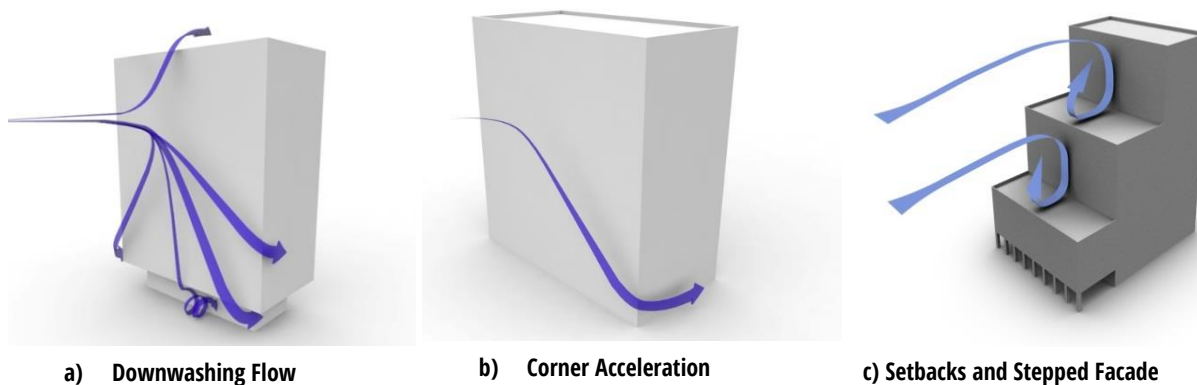


Figure 4: General wind flow phenomenon around buildings

5.2.1 Pedestrian Comfort

Detailed discussion on the potential wind comfort conditions at key pedestrian areas on and around the Proposed Development are provided in this section.

Thoroughfares

The north and east sides of the Proposed Development are protected from the prevailing southwesterly winds by the proposed and existing buildings. Also, the stepped north building facade will keep the prevailing northeasterly winds away from the ground. As a result, wind conditions on ground-level thoroughfares around the Proposed Development including Friar Street and Market Place are expected to be predominantly suitable for standing use during both summer and windiest season. Calmer wind speeds, suitable for sitting, are expected at sheltered areas to the north and east of the site as well as at the public thoroughfare between the two portions of the development. These conditions are appropriate for the intended use of the thoroughfares.

As a result of interaction of the prevailing winds with the tall south building façade, slightly higher wind speeds, comfortable for strolling, might occasionally be experienced at the Market Way on the south side of the Proposed Development, during the windiest season. These conditions are still acceptable for the intended use as this area is not intended for passive pedestrian activities.

Entrances

Residential entrances are located along the east building façade and within the public thoroughfare between the two portions of the development (marked by red triangles in Figure 5). Retail entrances are located along the north, south and east facades, and within the public thoroughfare between the two portions of the development (marked by green triangles in Figure 5). North and east sides of the building are generally protected from the prevailing winds from the southwest, by the Proposed Development and the existing buildings to its west and south. Calm wind conditions are also expected within the public thoroughfare between the two portions of the development as it is generally protected by the buildings surrounding it. Wind conditions at the entrances at these areas are expected to be comfortable for sitting or standing

throughout the year, which is appropriate for the intended use. Appropriate wind conditions are also expected at the retail entrances on the south side of the building as they are within a recessed colonnade, therefore protected from accelerated winds along Market Way.

When the doors leading to the public thoroughfare, on its south side, are open, winds are expected to accelerate through this opening and result in wind speeds that are potentially higher than desired at the residential entrance on the south side of the public thoroughfare, during the windiest season (Location A in Figure 5). We recommend recessing the entrance from the building façade for approximately 1.5 m or installing a wind screen with a similar depth on its south side which can help to protect it from the stronger winds. Examples of these mitigation features are shown in Figure 6.



Figure 5: Ground floor plan showing the location of entrances



Figure 6: Examples of mitigation measures at the south residential entrance

5.2.2 Strong Winds

Strong winds in excess of 15m/s for more than 0.025% of the year are associated with areas where conditions are suitable for walking use or are uncomfortable. As there are no instances of these conditions, we would not expect there to be instances of strong winds which would cause nuisance to pedestrians.

6. CONCLUDING REMARKS

A qualitative wind assessment was conducted to assess the wind microclimate around the proposed 173-175 Friar Street and 27-32 Market Place development in Reading, UK. Meteorological data for the site indicates prevailing winds from the south-westerly quadrant throughout the year, with colder north-easterly winds during the spring months.

Overall, the wind microclimate around the Proposed Development is expected to be generally similar to the existing conditions and suitable for the intended use on and around the site including public thoroughfares and most entrances. However, conditions are expected to be occasionally windier than desired at the residential entrance on the south side of the public thoroughfare, during the windiest season. Wind mitigation features have been recommended which can help to improve the conditions at this location. Wind conditions are expected to be acceptable for the intended use, if the recommended mitigation features are implemented.

7. REFERENCES

1. Lawson T.V. (April 2001), Building Aerodynamics, Imperial College Press